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12 January 1998

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POC: National Air & Space Warfare
Date: Mar 19, 1996

Marine Corps Addendum to
the
JSIMS ORD

1. General Description of Operational Capability

(see Joint ORD)

2. Threat: Not Applicable

3. Shortcomings of Existing Systems

The current constructive simulations used for training in the Marine Corps are primarily the MAGTF Tactical Warfare Simulation (MTWS) and to support high resolution requirements the Joint Tactical Simulation (JTS) and the Joint Conflict Model (JCM). MTWS was designed to support Marine Corps commander and staffs. MTWS is also a member of the Joint Training Confederation of simulations. The JTC allows limited communication between the simulations via the Aggregate Level Simulation Protocol. Due to this limit Marine Corps warfighting capabilities are inadequately represented in the JTC. For high resolution exercises the MTWS does not represent events as well as the JTC. However, MTWS and JTS do not have an interface with each other. Only JTS with its Distributed Interactive Simulation protocol would be able to provide a synthetic environment to virtual simulators and live instrumented ranges and units. Neither simulation has an interface to Marine Corps C4I systems and both require significant effort to build scenario databases and exercise overhead in terms of controller and response cell workload.

4. Capabilities Required

<u>System Performance</u>

4.1.1 <u>General</u>. In supporting a tactical exercise, the JSIMS must accept, store, process, generate, and display comprehensive data on the simulated operations of the modeled forces. The System must accept data input by terminal operators using keyboards, pointing devices, and voice. Data which must be retained for later access must be stored on mass storage, magnetic media. Data processing and information generation must be performed to provide controllers and players with continuously updated information for centralized, near-real-time control of exercise play. This information must take the form of advisory, cautionary, and status tabular displays as well as graphic displays portraying the current tactical situation.

4.1.2 The data must be stored for retrieval as needed during the exercise and for after action review.

DRAFT

National Air and Space (Warfare) Model (NASM)
Technical Requirements Document (TRD)

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National Air and Space (Warfare) Model (NASM)
Technical Requirements Document (TRD)

1. Program Definition and System Overview

National Air and Space (Warfare) Model (NASM) will be a distributed simulation system that provides an air/space joint synthetic battlespace that will meet the operational needs of the USAF. NASM will provide the functional capability to realistically represent the full range of aerospace power applications (including supporting functionalities such as, logistics, intelligence, medical, engineering, communication, geophysical, meteorological, oceanographic, space, environmental factors, and information warfare) for both Air Force specific and joint training.

NASM will provide an operationally realistic, distributed, simulated mission space that includes a synthetic environment, force representation, and behavioral representation. NASM will be used by commanders and battlestaffs (from wing level up to and including Joint Force Air Component Commander (JFACC)), and other organizations as needed to support global, theater, regional training and readiness exercises; education and seminar training; development of doctrine and practice of operational art; situation assessment; and the formulation, assessment; and rehearsal of operational plans. NASM shall support training exercises over extended geographical distances.

NASM will interface with real world Command, Control, Communications, Computers, and Intelligence (C^4I), and support systems to provide resource efficient and intuitive interfaces for training execution in the places these operations would normally be conducted. The NASM domain will include the full spectrum of air and space operations (including Force Application (Strategic Attack, Interdiction, Close Air Support (CAS)); Aerospace Control (Defensive Counterair (DCA), Suppression of Enemy Air Defense (SEAD), (Offensive Counter Air (OCA)); Situation Assessment/C3I (Battle Management, Communication, Reconnaissance, Intel); Mobility (Airlift, Refueling), military operations other than war (MOOTW), information warfare, and special operations. NASM will be flexible and extensible to incorporate additional functionality and evolve to address additional modeling user communities, (e.g., analysis, test & evaluation, acquisition) and operational needs, (e.g., decision support, tactics trials).

NASM will be developed, deployed, operated, and maintained in a cost effective and efficient manner. To provide a maintainable system with a evolutionary life-cycle, NASM will be developed using modern computer technologies, software engineering, open system interfaces, and will maximize the use of off-the-shelf hardware, software, validated algorithms, and real world databases.

1.1 System Description and Architecture

The joint synthetic battlespace is an operationally realistic, distributed, simulated mission space that includes a synthetic environment, force representation, and behavioral representation. NASM represents those objects which are specifically USAF assets, as well as those areas of interest in which those assets may interact (e.g., OPFOR, neutrals, ground targets, infrastructure for information operations, et al).

The NASM architecture will be a flexible framework that will integrate representations of the various missions of the Air Force. This NASM framework will consist of a distributed, discrete event, constructive simulation with the capability to interact with virtual and live simulations and simulators. The NASM framework will support multiple levels of resolution in accordance with user needs. It will be developed in conjunction with other major programs addressing simulation components and standards.

The NASM system will be based upon an open system architecture, non-proprietary software, higher order programming languages, and off-the-shelf software and hardware. The NASM system will be capable of executing as a standalone simulation or as part of a federated simulation system. NASM will have the ability to interface with real world C4I interfaces (simulated or live).

NASM will be a next generation distributed discrete event, object oriented, composable simulation system. The NASM system will embrace a number of architectural principles:

- NASM will comply with the DoD Modeling and Simulation High Level Architecture (HLA). Where technically feasible, NASM will comply with the HLA internally, although this only refers to interface specifications as opposed to reuse of reference RTI implementations.
- NASM will be consistent with objects described by the Federation Object Model (FOM).
- NASM objects will use HLA Run Time Infrastructure (RTI) services for coordination with other simulations and transfer of data.
- NASM entity representation range from sub-components to aggregate units. Entities will have discrete behaviors (not simply the aggregation of component behaviors)

NASM provides for fully automated computer generated forces (CGFs), semi-automated forces (SAFORs), command center and warfighter-in-loop (WITL) forces at any echelon in any permutation for multiple sides. Depending upon the exercise, NASM could run from fully automated to fully manned.

The NASM system will provide several different environments to be used in each of the phases of a NASM exercise. The pre-exercise environment will be used by the training staff during the exercise preparation to do planning and setup of the exercise. The Execution Environment will be used by the training staff, the exercise controllers, and the trainees during the running of the exercise. The post-exercise environment will be used by the training staff for exercise review, which will take place both during the running of the exercise execution and in post-exercise analysis.

1.2 Components

NASM will allow the interoperability of object-based software components in distributed heterogeneous environments. Intra-simulation interoperability must be at least as flexible as the Object Management Group's (OMG) Object Management Architecture (OMA) Reference Model. NASM will allow multiple component systems to be run on the same computing platform and a single system's components to be distributed amongst many geographically dispersed computing platforms. NASM will provide common facilities and services where usable by more than one group of objects.

1.2.1 Objects

NASM will provide a common object format for intra-simulation interoperability using a robust and reliable (assured) distributed object message/interaction protocol. Mechanisms will be provided for distributed object visibility triggers to reduce wide area network traffic. The object format will provide a consistent interface for inter-simulation interoperability (e.g., within JSIMS).

1.2.2 Common Facilities

NASM will provide common facilities comprised of tools and reusable shared software components for use by service objects and models. The common facilities contain the agreed-to representations of how USAF forces operate. These representations are contained in structures such as class libraries, data bases, and object repositories. These facilities will include environmental, force, support, simulation management, and activity model components.

1.2.3 Common Services

NASM will provide common services comprised of tools and reusable shared software components for use by service objects and models. Services will be products that range from low-level system utilities to higher-level applications, such as database management. Common Services will be comprised of components which meet Government and industry standards promoting open architecture in a multiple vendor heterogeneous environment. These services include such components as: network services, graphics, security, operating systems, documentation, instrumentation, system management, distributed computing environment, knowledge servers, and other services.

1.2.4 Application Tools

Application tools will be developed, including scenario generation, simulation controls, system control, archive utilities, and others. All NASM application tools will meet the technical goals of the NASM framework.

The NASM Architecture will include tool frameworks which will specify the required interface between applications and the architecture to achieve reliable, portable operation in a distributed environment.

1.3 Requirements Baseline

As the NASM system is developed, changes to the system and requirements are anticipated. This TRD describes all currently known requirements and provides insights into the NASM "growth" areas. To establish an initial baseline for each external interface system, the latest version of the system's ICD and external system software will be used at the onset of the NASM system development. The external system software will prevail when there is a discrepancy between the ICD and the software. The NASM system must be flexible so that changes to the external system interfaces may be incorporated to provide interoperability with releases/upgrades of identified and new external systems.

1.4 Document Overview

This document establishes the functional and performance requirements for NASM. This document also provides technical guidance for NASM. The requirements and guidance within this document describe initial operational capabilities (IOC) required, the initial sites where NASM will be fielded, and full operational capabilities (FOC) and additional sites where NASM will be fielded. The NASM system as described can be: standalone to support Air Force training exercises or educational seminars; or integrated with larger simulation systems such as, JSIMS, to support joint training exercises.

Section 1 of this document provides a system overview. Section 2 contains a list of references. Section 3 describes the system capabilities to be provided by the NASM system. This document provides the Government's current understanding of NASM and its evolution. Section 3 does not provide a detailed set of requirements; rather a high level set of functional and performance requirements that will be used as the basis for the NASM system specification. Within section 3 all requirements are denoted with a "shall". A "will" or "must"denotes a goal and provides more information related to a system requirement and system objectives. Sections 4 and 5 are not applicable. Section 6 provides a notes that present the reader with some design and implementation considerations. Section 6 is non-binding and intended for information purposes only. The

Appendices contain a glossary, a functional description of IOC/FOC capabilities, and an acronym list.

2. Applicable Documents

2.1 Government Documents

2.1.1 Specifications

DMSO Department of Defense (DOD) High Level Architecture (HLA) for Simulations, Interface Specification, Version 0.4, dated 7 March 1996

2.1.2 Standards

DOD Technical Architecture Framework for Information Management (TAFIM), Air Force Technical Reference Codes (TRC)

DOD Technical Architecture Framework for Information Management (TAFIM), Reference Models and Standards Profile, Version 2.0, dated 1 November 1993

2.1.3 Other Publications (Reference Only)

Air Force Manual 1-1, Basic Aerospace Doctrine of the United States Air Force, Volumes I and II, dated March 1992

Air Operations Center, ACCI 13-150 (draft), dated 26 October 93 (draft)

CACI Prototype Architecture Specifications, Rev. 02.1, dated 5 January 1995

CACI Protoype Final Process Redesign Plan, 29 September 1995 (CACI prototype document)

CACI Prototype Software Requirements Specification for NASM, dated 12 December 1995

DMSO DOD High Level Architecture (HLA) Management Plan, dated 17 July 1995

DMSO DOD High Level Architecture (HLA) Object Model Template, dated 17 July 1995

System Design Document for AWSIM/R, TRN 11, dated 8 September 1995

System Specification for AWSIM/R, TRN 11, date 28 July 1995

USAF Air Force Doctrine Document (AFDD) 1, Air Force Basic Doctrine, dated 15 August 1995, First Draft

USAF Air Force Doctrine Document (AFDD) 3, Military Operations Other than War, dated 5 December 1995, Proposed Final Draft

USAF Air Force Doctrine Document (AFDD) 35, Special Operations, dated 16 January 1995

USAF Air Force Doctrine Document (AFDD) 5 Information Warfare, Preliminary Draft, dated xx, 1995

Warrior Preparation Center Planning Conference Workbook, dated April 1994

2.2 Non-Government Documents

TBD.

2.2.1 Specifications

TBD.

2.2.2 Standards

TBD.

2.2.3 Other Publications

TBD.

3. System Requirements

NASM shall provide an operationally realistic, distributed, simulated mission space that includes a synthetic environment, force representation, and behavioral representation. NASM will be used by commanders and battlestaffs (from wing up to and including Joint Force Air Component Commander (JFACC)), and other organizations as needed to support global, theater, regional training and readiness exercises, education and seminar training, development of doctrine and practice of operational art, situation assessment, and the formulation, assessment, rehearsal of operational plans. NASM shall support training exercises distributed over extended geographical distances using wide-area networking (WAN) technologies.

3.1 Types of Users

NASM shall provide a simulation system framework adaptable to many modeling and simulation applications. NASM shall have three classes of users -- end users (e.g., battlestaffs receiving training or students playing wargames during educational seminars), technical controllers (those who set up and run the simulations), and developer/maintainers.

3.1.1 End Users

NASM shall initially focus on the operational readiness environment at the campaign level, addressing the complete USAF operational environment, including USAF commanders and battlestaffs (up to and including Joint Forces Air Component Commanders (JFACCs)), and related mission organizations. NASM shall provide the capability to conduct training for battlestaffs at the AOC down to (and including) the wing level (with or without participation by higher and collateral level staffs) through improved simulation of agencies external to the battlestaff being trained. Conversely, when lower levels are not represented as player elements in an exercise, NASM shall have the capability to realistically portray their presence to the higher level staffs. See Figure 3-1.

Figure 3-1. Simulation System Participants

3.1.1.1 NASM shall also focus on the educational community requirements. The educational audience plays the roles of a theater CINC, supporting air, ground, and

sea component commanders and their supporting staffs. Seminars of students consist of active, reservesk and civilian force and have varied speciality areas. Approximately only 30 percent of the students have an operational background.

3.1.2 Technical Controllers

NASM will provide the capability to incrementally automate many of the manpower intensive control functions typical to existing simulations throughout the exercise time frame - planning, scenario generation (intelligent laydown of friendly and opposing forces), execution (knowledge-based system order validation), post-processing analysis, and after-action reviews. NASM technical controllers shall have the ability to start, freeze, stop, restart, rollback, shutdown, save the state of all data in the system, record selected events, select the time-step in which to operate, and control system configuration (i.e., distributed, single site). NASM technical controllers shall have the ability to:

a. initiate an exercise, control the exercise via exercise parameters, interject events, and monitor the exercise and its results;

b. define (during pre-simulation) and adjust (during simulation system execution) all scenario elements and wargame conditions, including definition of sides and responsibilities in support of an exercise;

d. end the exercise. Ending the exercise will not allow the exercise to be restarted. However, an exercise can be restarted within 10 minutes from a saved checkpoint or the exercise may be played back for debriefing purposes;

d. pause and resume the exercise;

e. initiate checkpoint/state save;

f. select After Action Review (AAR) and mission report data to be collected and stored during an exercise;

g. select data and reports to be generated and printed before, during, and after the simulation execution;

h. define and store user defined report formats;

i. set and change the logical time scale and absolute exercise time during the exercise;

j. support the full range of all service/branch coordinate systems;

k. manage the range of interface objects, devices, and systems, including the user views for each side (allied, opposing, neutral, unknown, etc.) of the game;

l. change the status of the simulated entities. For example, controllers may have the ability to relocate units, resupply units, restore equipment, disable equipment, change the damage status of roads, bridges, airfields, etc.;

m. insert events and activities related to information warfare;

n. allow the centralized management of up to a minimum of 44 independent, simultaneous, executions of simulation(s).

The number of technical controllers required to support an exercise will vary depending upon the exercise and training objectives; however, the number of technical controllers shall not exceed 5 per exercise node during simulation execution. (Exercise node refers to a physical geographic location. However, it is possible that one facilty may model multiple geographic locations (exercise nodes) for the purposes of training.)

3.1.3 Developer/Maintainers

NASM shall establish a development architecture that consists of automated support tools to facilitate wide-spread, cooperative development of simulations using a common design implementation methodology. The development architecture shall provide common development facilities to permit multiple-resolution representations of entities and environments to facilitate flexible, extensible, and consistent use of simulations.

3.1.4 Additional User Communities

NASM shall be flexible and extensible to incorporate additional functionality and evolve to address additional modeling user communities, (e.g., analysis, test & evaluation, acquisition) and operational needs, (e.g., decision support). The initial design shall be sufficiently flexible to accommodate these expanded requirements, shall ensure that objects, data and algorithms employed are consistent with documented or commonly accepted standards used in these communities; and shall provide an architecture and connectivity for collecting and organizing simulation outcomes and their underlying event and input data.

3.2 Functional Requirements

The NASM system shall provide simulation capabilities for pre-exercise, exercise execution, and post exercise analysis in the simulation system use exercise lifecycle. See Figure 3-2.

Figure 3-2. Functional View of NASM

3.2.1 Pre-Exercise

The pre-exercise functionality shall provide a distributed/collaborative planning, user friendly means for the NASM technical controllers to generate scenarios and support exercise preparation.

3.2.1.1 Scenario Generation

The NASM system shall provide a collaborative scenario generation subsystem that allows the users to create, modify, delete, copy, merge, store and catalog scenarios over geographic dispersed sites. A minimum of 3 technical controllers shall be able to concurrently develop the same scenario. The NASM scenario generation subsystem shall provide an audit log to track the changes made to the scenarios during the scenario generation process.

Exercise scenario generation shall provide the capability to define scenarios to support the missions defined in section 3.3 of this TRD. Exercise scenario generation shall provide the capability to create/establish the initial scenario elements and wargame conditions. The process of creating a scenario shall be automated to the maximum extent feasible, including automating the process of obtaining data from external real world C4I systems, and other sources of scenario data such as, Defense Intelligence Agency's (DIA's) Multi-Spectral Force Deployment (MSFD) data, and DoD mapping data. The initial scenario elements shall include such data as, but not limited to: assets (including space assets and sensors), laydowns and Order Of Battle (OOB) information, routes, weapons, engagements, threat definitions and laydowns, target definitions and laydowns, events and activities related to information warfare, all sides (multiple) within an exercise, number of end users, and end users' views of the wargame. The wargame conditions include shall such data as, but not limited to: wargame configuration (including communications, real world interfaces), exercise report data and collection, wargame configuration, wargame speed, data collection and storage, environmental conditions, and level of aggregation/deaggregation. The scenario elements and wargame conditions shall be adjustable during an exercise by the technical controllers.

Scenario generation tools shall access the static environmental data present in the common facilities to create a dynamic environment for the system, capturing the effects of weather and operations on the mission space (e.g., smoke, fog, biological and chemical weaponry) and ensuring distributed consistency of the environment through out the exercise.

The NASM system shall provide the ability to permit the technical controllers to store complete and partial scenarios and scenario data. NASM shall store scenarios and scenario data in such a manner that promotes reusability of the scenarios and scenario data. The NASM system shall provide the technical controllers with the ability to catalog and retrieve stored scenarios.

3.2.1.2 Pre-Exercise Simulation System Support

Exercise preparation shall support capabilities such as, but not limited to: establishing the exercise configuration; and supporting verification and validation of scenario data and scenarios.

3.2.1.3 Establish Exercise Configuration

The NASM system shall provide the technical controllers with the capability to define the exercise system configuration for all types of users. This capability provides the technical controllers with the capability to select the physical workstation configuration for the exercise. The physical exercise configuration shall be changeable (manually or dynamically) during an exercise.

The technical controllers shall be allowed to define the simulation configuration. The simulation configuration shall define data such as, but not limited to: the physical real world system connectivity (simulated or live), external simulation system interfaces, level of aggregation/deaggregation, and communication links that will be modeled as part of the simulation system. Tools shall be provided to stress test the physical exercise configuration for load and performance criteria without executing the actual exercise.

3.2.1.4 Scenario Verification and Validation

The pre-simulation capabilities shall support the scenario verification and validation process. The scenario verification and validation process shall allow the user to preview the scenario based upon time, event, entities, and scenario notes. During the scenario verification and validation, the technical controller may be allowed to modify the scenario.

3.2.2 Simulation System Execution

NASM shall provide the ability to execute the scenarios to support the operational training and readiness, as well as educational communities. During the simulation execution, the NASM system shall:

a. accept and respond appropriately to user input from the technical controllers and end-users;

b. create and maintain an event log in a time-ordered sequence of all events occurring in the simulation execution, and at periodic or controller initiated checkpoints, including state saves to adequately to restart the simulation at given checkpoints;

c. automatically collect and store on-line all data (e.g., AAR report data, performance, metrics) that has been selected for collection by the technical controllers without degrading the performance of the NASM simulation execution;

d. execute at the wargame simulation speed to the logical time selected by the technical controllers, including discontinuous time changes;

e. interface with external simulation systems and/or real world C4I interfaces as specified in the simulation configuration;

f. be capable of executing standalone (unfederated) or as part of a federated simulation system; and

g. the ability to define and store user defined report formats.

The NASM system simulation execution shall support the following characteristics: sides, aggregation/deaggregation, behavioral representations, ground truth, and simulation time.

3.2.2.1 Sides

NASM shall represent multiple sides (at a minimum of 10), including multiple services from multiple nations in coalition (with joint forces component commanders), neutral forces (which may convert to active participants during exercise execution), and opposing forces (with similar organizational characteristics). All sides shall have the same simulation system functional capabilities (i.e., think, move, communicate, shoot, etc.). However, within NASM, each side shall have the capability to act or be represented differently. NASM shall have the capability of allowing each side to have multiple views allowing the perceived truth for each view of a side to be different .

3.2.2.2 Aggregation/Deaggregation

NASM shall provide for multiple user communities by providing multiple levels of resolution (NOT variable resolution which infers a continuous analog resolution rather than the actual requirements for steps of resolution) with aggregation and deaggregation of decisions and entity representations simulations at all levels (from component through units). At the aggregate level, NASM shall allow for two or more entities to be viewed as a single entity during the simulation (e.g., a flight). Behavior shall be represented discretely at each level of aggregation (e.g., a flight has unique behaviors which must be modeled explicitly, not simply the addition of its component parts). Interactions among simulated entities shall be resolved at comparable levels of resolution, only requiring decomposition to the platform level or below as required. NASM shall provide the ability for aggregated entities to be viewed as individual entities during an exercise. See Section 6.0 for more information on Aggregation/Deaggregation.

3.2.2.3 Behavioral Representation

NASM shall represent the full range of probable behaviors of forces and all supporting activities (e.g. command centers). NASM shall provide for Warfighter-in-the-Loop Semi-Automated Forces (SAFORs) and fully automated Computer Generated Forces (CGFs) to represent both friendly, neutral, and Opposing Forces (OPFOR) at all applicable levels from platform (thinker) entity task frames to command decision logic. Metaobject (multiple resolution) and Multiobject (similar and dissimilar object groups) behavior shall be supported. A NASM exercise shall be able to run without any personnel resources being utilized for control representation of opposing forces (intelligent enemy) or any forces (fully automated). Entity behavior (platform through command centers) shall be modeled discretely at the respective level of representation).

3.2.2.4 Ground Truth

The simulation system shallsupport ground truth and entity based perceived truth. Ground truth shall be maintained separate and distinct for use by the simulation executive, and externally by the exercise control staff. Perceived truth shallbe used for automated and semi-automated behavior decision processing and Warfighter In The Loop (WITL) participants. The simulation system shall allow entity interactions (platform to unit) using only perceived truth.

3.2.2.5 Simulation Time

NASM shall have the ability to run at rates ranging from Slower than Real Time (SRT), to Near Real Time (NRT) to Faster than Real Time (FRT). Simulation time shall include event driven synchronous, event driven asynchronous and scaled time driven (real time: simulation time) as a subset of a discrete event. Time compression factors shall be selectable within a range from 1/10th to 100 times real-time. NASM shall be capable of executing faster than real time (at least 2:1) while supporting a multiple Major Regional Contingency (MRC) scenario with maximum level of resolution and full participation of training audiences down to the wing level. With SAFORs, NASM shallbe capable of executing a multi-MRC scenario at a speed of 10 to 1. With CGF and only high level inputs, NASM shall be capable of executing at a speed to 100:1 (30 days in 7.2 hours). NASM will be capable of executing at a speed of 240 to 1 (15-30 days in 3 hours). NASM shall be extensible to support the maximum speed of 1000:1 (This speed is envisioned for analytical purposes only.)

NASM shall be capable of jumping backward in time to support simulation restart or simulation replay.

In addition to the time ratio, a variable time step interval between 1 and 60 seconds shall be supported. Nominally, a time-step of 6 seconds is desired.

3.2.3 Post Exercise

The NASM system shall provide the ability to debrief exercise participants and support the After Action Review (AAR) process including the exercise hot-wash. The NASM system shall provide the users with the ability to assess the effectiveness of the exercise and to provide realistic training and conduct post exercise analysis (e.g., examination of doctrinal issues, analysis of logistics and force support issues, and evaluate force employment operations, and intelligence issues). The post exercise capabilities include the ability to generate predefined and user defined reports, and to perform simulation system playback.

3.2.3.1 After Action Review (AAR) Process

In support of the AAR process, NASM shall provide the capability to track special or high interest information, provide automatic detection of events based upon common errors, compare ground truth information from the simulation databases with each of the end users (i.e., players) perceived truth.

3.2.3.2 Predefined and User Defined Reports

The NASM system shall have a standard set of predefined reports. The standard reports shall include data reports such data as, but limited to: damage assessment, weapons expended, aircraft losses, mission results, kills claimed, and status reports. Data necessary for the predefined reports shall be collected automatically. Predefined reports shall be automatically generated at the end of an exercise, as appropriate.

NASM shall provide the technical controllers with the ability to generate user-defined reports during the simulation system execution and post exercise analysis. The user-defined reports can be generated based upon simulation events, results, and/or time.

After action reviews shall be available for hot wash within two hours of end of exercise.

3.2.3.2.1 Post Exercise Analysis

Tools shall be provided to allow in depth post-exercise analysis based on archived data.

3.2.3.3 Simulation System Playback

As part of the post exercise debrief the NASM technical controllers shall have the ability to playback a portion of an exercise or a complete exercise.

3.3 Missions

NASM shall provide appropriate models to represent all the AF missions including aerospace, military operations other than war (MOOTW), information warfare, and special operations. NASM shall have the capability to support exercises that transition between all the AF missions. The models shall be based upon official data. The NASM system shall meet the Validation, Verification, and Accreditation criteria in accordance with USAF directives and guidance.

3.3.1 Aerospace Missions

The NASM system includes representations of the following types of missions: aerospace control, force application, force enhancement, and force support.

3.3.1.1 Aerospace Control

NASM shall have the capability to model aerospace control missions: counterair and counterspace. Both of these missions can be divided into offensive and defensive objectives.

a. Counterair

Offensive aerospace control shall include the ability to seek out and neutralize or destroy enemy aerospace forces and ground-based defenses. The objective of counterair is control of air. The following types of counterair (offensive and defensive) shall be modeled within NASM: sweep, escort, air defense, and airborne electronic warfare.

b. Counterspace

Defensive aerospace control shall model that ability to control operations, detect, identify, intercept, and destroy enemy aerospace forces. The objective of counterspace is control of space.

3.3.1.2 Force Application

Force application missions apply combat power against surface targets excluding missions whose objectives are aerospace control. NASM shall model the following types of force application missions: strategic attack, interdiction, and Close Air Support (CAS).

a. Strategic Attack: The objective of a Strategic attack mission is to destroy or neutralize an enemy's war-sustaining capabilities or will to fight.

b. Interdiction: The objective of an Interdiction mission is to delay, disrupt, divert, or destroy an enemy's military potential before it can be brought to bear against friendly forces.

c. CAS: CAS missions support the surface commander by destroying or neutralizing enemy's forces that are in proximity to friendly forces.

3.3.1.3 Force Enhancement

Force enhancement increases the ability of aerospace and surface forces to perform their missions. NASM shall model the following types of force enhancement missions: airlift, air refueling, spacelift, electronic combat controls, and intelligence, surveillance and reconnaissance.

a. Airlift: Airlift provides for transportation of resources (people, equipment, materiel) rapidly without regard to surface obstacles.

b. Air Refueling: Increases the ability of aircraft by extending their range, payload, and endurance.

c. Spacelift: Spacelift transports resources (people, equipment, materiel) to and through space.

d. Electronic combat: Electronic combat controls, neutralizes or destroys the enemy's electromagnetic capabilities.

e. Intelligence, Surveillance and Reconnaissance: Intelligence, surveillance and reconnaissance provides data needed for effective combat operations.

3.3.1.4 Force Support

Force support must sustain operations that contribute to the success of aerospace forces. NASM shall model the following force support functionality: base operability and defense missions, logistics, combat support, and on-orbit support.

a. Air Base Operability (ABO) and Defense: Air Base Operability and defense includes defending an aerospace installation from attack, helping aerospace forces survive an attack, and returning installations to full capability post attack.

b. Logistics: Provides assets for and sustains aerospace forces.

c. Combat support: Combat support provides support to organizations and personnel in operational condition.

d. On-orbit support: On-orbit support keeps platforms in space operating as effectively and efficiently as possible.

3.3.2 MOOTW Missions

NASM shall have the capability to support MOOTW exercises. MOOTW operations include three classes: combat, noncombat, and an overlapping between combat and noncombat. NASM shall provide the capability to create realistic (including joint interagency, non-governmental organizations, private voluntary organizations, media participation, and space force) and challenging exercises to support the training of all the MOOTW missions. NASM shall be capable of creating and executing exercises that emphasize employment, deployment, and redeployment phases, as well as transitions to and from war. The NASM MOOTW models shall: interface with C4I systems, employ appropriate laws, and include logistics coordination.

3.3.2.1 Combat MOOTW Missions

NASM shall support the following combat MOOTW missions: enforcement of sanctions, enforcement of exclusion zones, protection of shipping, strikes and raids. Aerospace and space contributions to the combat MOOTW missions shall include capabilities such as, but are not limited to: airlift, close air support, combat search and rescue, counterair, counterspace, interdiction, strategic attack, surveillance, and reconnaissance.

3.3.2.2 Noncombat MOOTW Missions

NASM shall support the following noncombat missions: arms control support, domestic support operations, foreign humanitarian assistance, nation assistance, show of force, and support to insurgency.

3.3.2.3 Overlapping MOOTW Missions

NASM shall support the following missions that overlap between combat and noncombat: combating terrorism, counterdrug operations, ensuring freedom of navigation, noncombatant evacuation operations, peace operations, recovery operations.

3.3.3 Special Operations Missions

NASM shall have the capability to model for the purposes of training special operations missions. These missions shall include: unconventional warfare, direct action operations, special reconnaissance, counterterrorism, foreign internal defense, and psychological operations. NASM shall have the capability to create and execute exercises that include the special operations missions.

3.3.3.1 Unconventional Warfare

NASM shall have the capability to model unconventional warfare that includes guerrilla warfare and other direct offensive, low visibility, covert or clandestine operations, as well as the indirect activities of subversion, sabotage, intelligence collection, and evasion and escape.

3.3.3.2 Direct Action Operations

NASM shall provide the capability to model direct action operations that are short-duration strikes and other small scale offensive actions principally taken by Special Operations Forces (SOF) to seize, destroy, or inflict damage on a specified target; or to destroy, capture, or recover designated personnel or material.

3.3.3.3 Special Reconnaissance

NASM shall provide the capability to model reconnaissance and surveillance actions conducted by SOF to obtain or verify, by visual observation or other collection methods, information concerning capabilities, intentions, and activities of an actual or potential enemy.

3.3.3.4 Counterterrorism

NASM shall have the capability to model counterterrorism which consists of offensive measures taken to prevent, deter, and respond to terrorism, including intelligence gathering and threat analysis in support of those measures.

3.3.3.5 Foreign Internal Defense (FID)

NASM shall have the capability to model FID. FID provides U.S. military expertise to other governments in support of their internal defense and development efforts.

3.3.4 Information Warfare

NASM shall have the capability to include events and activities related to information warfare. The events and activities shall include actions taken to deny, exploit, corrupt, or destroy an adversary's' information and its functions, while protecting friendly forces against similar actions and exploiting organic military information functions. Information warfare representations shall include the following functionality: Psychological operations, military deception, electronic warfare, physical attack, information attack, and security measures. NASM shall allow these events and activities to occur during the simulation execution.

3.3.4.1 Psychological Operations

Psychological operations convey selected information and indicators to foreign audiences to influence their emotions, motives, objective reasoning and ultimately the behavior of foreign governments, organizations, groups, and individuals. The purpose of PSYOP is to induce or reinforce foreign attitudes and behavior favorable to the originator's objectives. The affect of PSYOP shall be adequately represented within the simulations. NASM shall have the capability to model PSYOP forces that can support strategic, operational, tactical, or consolidation PSYOP objectives by providing intelligence, leaflet delivery, or media broadcasts.

3.3.4.2 Military Deception

Military Deception shall be represented within NASM. Military deception seeks to mislead foreign decision makers, causing them to act in accordance with the originator's objectives. Deception strategies may support national policies, military service programs, or tactical operations. Measures are designed to distract from, or provide cover for, military operations. These measures require accurate intelligence on the adversary's cultural, political, and doctrinal perceptions to be modeled through the use of assets represented within the simulation. Scenario planners and technical controllerswill then be able to exploit and manipulate those biases which will affect the simulation execution.

3.3.4.3 Electronic Warfare (EW)

EW shall be represneted as is military actions involving the use of electromagnetic and directed energy to control the electromagnetic spectrum or to attack an adversary. EW creates a correct representation of an electronic sanctuary in which friendly aircraft can operate during air and ground operations. This sanctuary enables strike and counterair aircraft to proceed to and from their targets and to fully exploit their modern technology weapons in relative safety.

3.3.4.4 Physical Attack

Physical Attack shall be represented which destroys information systems through the conversion of stored energy into destructive power. The coupling of Precision Guided Munitions (PGM) and advanced delivery platforms provide the required precision to accurately attack the adversary's C2. It increases the utility to attack C2. Additionally, the few aircraft required per target permits simultaneously striking a large array of the adversary's information operations vice sequentially.

3.3.4.5 Information Attack

Information Attack shall be represented which encompasses special communications and computer activities taken to manipulate or destroy an adversary's information functions. Penetration of an enemy's information systems has great value in combat because it offers the ability to incapacitate an adversary with reduced exposure to friendly forces. By using non-traditional tools, the conventional sorties can be saved for other targets. Manipulation of data bases or parameters of reporting systems can cause incorrect information for decision making, or destroy the enemy's confidence in the system. An effective information attack could force an adversary to use less technical means because of friendly intrusion into the system.

3.3.4.6 Security Measures

Security measures include programs designed to protect information that could be corrupted, destroyed, or exploited. Operations Security (OPSEC) and Information Security (INFOSEC) makeup the two basic elements of security measures. OPSEC is the process of identifying critical information and subsequently analyzing friendly actions in order to preclude observation by adversary intelligence systems. INFOSEC relates to the technical protection of information by Communications Security (COMSEC) and Computer Security (COMPUSEC) programs. INFOSEC may be the most critical element of security operations. The effects of security measures and their compromises shall be modeled within NASM.

3.3.5 Simulated Entities

The NASM system shall provide a joint synthetic environment battlespace that realistically portrays the real world. This synthetic environment shall model the following types of physical entities including, but not limited to: assets, sensors, equipment, communication links, environmental effects, space and logistics. The NASM use of entities means the entire range of physical characterizations from subcomponents to units.

In addition to providing models that represent the physical entities, the NASM system shall provide algorithms that accurately model the following: movement and navigation, detection, flights, targets, pre and post engagements (AAM, Beyond Visual Range (BVR), Within Visual Range (WVR), Air to surface, etc.), disengagements, damage assessment, (collateral, probability of kill, damage to all game entities), weapon effectiveness, combat assessments, and communications.

3.3.5.1 Assets

The NASM system shall model all assets necessary to support Air Force training exercises from wing up to and including the Joint Force Air Component Commander (JFACC) for the aerospace, MOOTW, information warfare, and special operations missions. The NASM system shall model all assets with realistic properties and attributes. Assets include, but are not limited to: aircraft, air bases, radar sites, missile sites, sensors, space assets, ships, carriers, Surface to Air Missile (SAM) sites, Short Range Air Defense (SHORAD) sites, High and Medium Range Air Defense (HIMAD) sites, , satellites, ground forces of interest, and targets.

3.3.5.1.1 Sensors

NASM shall model sensors including sensor characteristics and sensor operations and activities. Sensors shall be modeled realistically including the effects of environmental conditions (weather, terrain masking) and electronic combat. NASM shall model all theater level collection sensors and national assets (e.g., Rivet Joint, AWACS, Joint Stars). NASM shall model these sensors to the level of detail required to support battlestaff training. Simulated sensor outputs shall be explicitly modeled to support interfacing with real world systems.

3.3.5.1.2 Equipment

The NASM system shall model equipment, including equipment characteristics and capabilities. Equipment to be modeled within NASM shall include, but not be limited to: weapons, radars, jammers, cruise missiles, theater ballistic missiles, SAM, Air to Surface Missile (ASMs), Air to Air Missiles (AAMs), Transportable Erector Launcher Systems (TELS), bombs, and cargo.

3.3.5.1.3 Communications Links

NASM shall model the communication links and networks used within a theater to accurately reflect the real world. NASM shall provide capabilities to define theater communication link and network architectures as part of the modeling and scenario generation subsystem. Failures and degradation of network capabilities in communications links shall be modeled so they affect interactions within the simulation realistically.

3.3.5.2 Environmental Effects

The NASM system shall realistically model environmental effects on real world system interfaces and aerospace weapons systems during training exercises. These environmental effects shall be considered during the exercise execution. The technical controller shall have the ability to change the environmental effects during an exercise. NASM environmental effects include, but are not limited to: weather, day and night effects, air, space, sea, and terrain (natural and man-made), including dynamic terrain , electromagnetic, optic, and acoustic propagation, and interactions between environments.

3.3.5.3 Space

NASM shall model the following functionality: navigation including Global Positioning System (GPS) satellites and processing; communication satellites and links; missile warning systems; environmental monitoring satellites; and spacelift, including space based assets.

3.3.5.4 Logistics

NASM models shall include sufficient logistics detail and adequate logistics related events to simulate activities necessary to support exercises at the Air Operations Center (AOC) and Wing Operations Center (WOC) and train AOC and WOC logistics support personnel.

3.4 Interfaces

NASM interface categories include real world interfaces, other simulation systems, JSIMS, and virtual system interfaces. To the maximum extent feasible NASM shall use/adopt the HLA Run-Time Infrastructure (RTI) adopted by JSIMS or develop an HLA RTI to provide interoperability with other simulation systems and real world C4I systems.

3.4.1 HLA

The DMSO DOD HLA interface specifications provide a description of the RTI services required for achieving interoperability among the next generation of DoD simulations. Under HLA, models shall to conform to the Object Model Templates, interface with a formalized RTI definition, and applicable intra-federation standards. The first federation will be JSIMS, but we expect that NASM will become part of other HLA federations, each with its own Federation Object Models.

3.4.1.1 Run-Time Infrastructure

The HLA RTI provides services to simulations in a way that is analogous to how a distributed operating system provides services to applications. These interfaces are arranged into the five basic RTI service groups: time management, federation management, declaration management, object management, and ownership management. NASM shall provide the functionality of each of the five RTI services groups.

The five service groups describe the interface between the simulations and the RTI and the software services provided by the RTI for use by compliant simulations. The critical functions included in the RTI as they relate to simulations are:

- Participate in distributed simulation management
- Make import and export declarations to moderate data flow
- Interact with objects owned by another simulation by exchanging public attributes and events through the interface
- Dynamically transfer attribute ownership

Specifics related to the functions described here can be found in the draft DMSO DOD HLA Interface Specification. Where applicable, NASM shall adhere to the DMSO DOD HLA Interface specification in the following functional areas:

3.4.1.2 Time Management

NASM shall have the capability to coordinate the advance of time and the exchange of events between simulations in a federation. A federation of simulations can be treated as a single, large simulation. NASM Simulation time shall include event driven synchronous, event driven asynchronous and logical time driven (real time and simulation time) as a subset of discrete event.

3.4.1.3 Federation Management

NASM shall provide the capability to provide Federation Management which includes the capability to create, dynamically control, modify, and delete a federation..

3.4.1.4 Declaration Management

NASM shall have the capability to declareto the RTI their desire to both generate and receive object state information. In addition to object state information, the interactions generated and received by a simulation must also be declared. When a simulation publishes data, that data is available to all subscribing simulations.

3.4.1.5 Object Management

NASM shall have the capabilty to create, modify, and delete objects and their interactions.

3.4.1.6 Ownership Management

NASM shall provide the capability to allow simulations to transfer the responsibility for modeling various object attributes. The ownership management services include continuity of ownership and symmetry of negotiations. Continuity of ownership are services which do not allow the current owner of an attribute to cease publication of values until the RTI has found a new owner that can assume that responsibility. Symmetry of negotiation refers to the ability of a simulation to initiate both the acquisition and divestiture of attribute ownership.

3.4.2 Real World System Interfaces

The NASM simulation system shall be capable of training USAF battlestaffs on their real world C4I equipment and/or simulated representations of the same equipment. NASM will fully support C4I through 1) real world system one and two-way data interfaces, and 2) transparent user interface to NASM using real world equipment (Computer-Human Interface). NASM must be capable of simulating all source Intelligence systems that provide inputs to Theater C4I systems (even if the real world systems are not physically present). Systems will range from air campaign planning tools down to command center and airborne C2 systems. To enhance realism, NASM must incorporate real world data bases into the simulation system and distribute the artificial mission environment to participating battlestaffs in the same manner as such information would be distributed during an actual contingency. Interface to these systems must be in their native system protocols. Where possible, the NASM HLA RTI shall be the mechanism to accommodate interoperability to the real world systems.

NASM shall provide the ability to manually input data in lieu of real world system interfaces and manually override data that is input from the real world system interfaces. The NASM shall have direct interfaces with the following real world systems: TBMCS, C2IPS, JDISS, TIBS, TRAP, TADIL, SOFPARS. Each of the interfaces are described below. NASM shall be capable of receiving, generating, and transmitting TADIL A, B, and J messages. NASM shall indirect interfaces with the following real world systems: ADANS, JCMT, GDSS, CMARP, TEP.

3.4.2.1 Theater Battle Management Core Systems (TBMCS)

a. CTAPS

During pre-simulation NASM shall be capable of exporting and importing scenario data from and to CTAPS databases.

During simulation execution, NASM shall be capable of:

- receiving and using the following messages from CTAPS: USMTF ATOCONF, USMTF ATO, and USMTF ACO.
- extracting and using an embedded ACO from an USMTF ATO or USMTF ATOCONF message.
- generating and transmitting messages and reports (e.g., MISREPs) over real world data links.
- accommodate Master Attack Plan (MAP) changes directly from the Air Campaign Planning Tool (ACPT)

b. Wing Command and Control System (WCCS)

During pre-simulation NASM shall be capable of exporting and importing scenario data from and to WCCS databases. During simulation execution, NASM shall be capable of:

- receiving and using the following messages from WCCS: USMTF ATO and TBD.
- extracting and using an embedded ACO from an USMTF ATO or USMTF ATOCONF message.
- generating and transmitting messages over real world data links following the following data: TBD.

c. Combat Intelligence System (CIS)

NASM shall receive target Battle Damage Assessment (BDA) data an integrate into the scenario planning process.

d. Standalone Tactical Operational Message Processing System (STOMPS)

TBD.

3.4.2.2 Command Control Information Processing System (C2IPS)

NASM shall interface with C2IPS.

3.4.2.3 Joint Deployable Intelligence Support System (JDISS)

During pre-simulation, NASM shall be capable of importing and exporting scenario data from and to the JDISS databases.

3.4.2.3 Special Operations Forces Planning and Rehearsal System (SOFPARS)

TBD.

3.4.2.4 Tactical Information Broadcast System (TIBS)

NASM shall generate and transmit a TIBS data stream to command and analysis locations participating in the exercise using operational data links supporting TIBS message protocols. Where applicable to the NASM models, NASM shall be capable of accepting and using a TIBS data through an interface to operational TIBS compliant tactical data links.

3.4.2.5 Tactical Receive Equipment (TRE) and Related Applications (TRAP)

NASM shall provide a capability to use TRAP terminal equipment as an operational data link supporting TIBS and other TRAP message protocols. NASM shall be capable of sending appropriate information into connected TRAP terminals for transmission to connected facilities. Where applicable to the NASM models, NASM shall be capable of obtaining information from the TRAP terminals and using the information.

3.4.3 External Simulation Systems Interfaces

NASM shall interoperate with other current and future constructive simulations, such as but not limited to: WARSIM 2000, JECEWSI, and JSIMS via the HLA RTI.

3.4.3.1 WARSIM 2000 Interface

NASM shall support a bi-directional interface via the HLA to WARSIM 2000.

3.4.3.2 JECEWSI Interface

JECEWSI is a joint electronic warfare model that simulates electronic combat and electronic warfare. The NASM interface with JECEWSI shall be bi-directional. NASM shall receive the jammer power and the electronic degradation factors for: C3, acquisition capability, launch capability, and self-protection jammer (SPJ). NASM shall send to JECEWSI the fixed wing aircraft information, aircraft update information (e.g., position, speed, status), emitter types and status.

3.4.3.3 JSIMS Interface

NASM shall be capable of operating as a stand alone model or integrated with JSIMS. NASM shall provide correct presentation of aerospace doctrine in exercises by providing the air and space objects (both system and behavioral representation) for use within the JSIMS federation. NASM shall be capable of taking advantage of the services and other components of JSIMS when executing stand alone or in a Federation. NASM shall provide all the air and space representations models necessary to support JSIMS including functionality below the joint components.

3.4.4 Virtual Interfaces

NASM will interoperate with virtual simulators and simulations and instrumented systems using protocols consistent with the DoD High Level Architectures. All such entity representations will be as surrogate objects within NASM.

3.5 System Architecture/Software Requirements

The software shall be developed to support the following open system characteristics:

- provide a "core" of support software and a suite of software tools and standards compliant with HLA architecture (and JSIMS) where necessary;
- reduce the number of, and special training required for, system administrators, network administrators, and other exercise support personnel;
- minimize life-cycle costs, and be logistically supportable;
- be flexible, extensible, and evolvable to support current and emerging commercial standards and incorporate upgrades, and commercially available software;

- provide sufficient flexibility and performance to support changes and extensions to the models;

- use COTS, GOTS, and NDI to the maximum extent feasible. It shall capitalize on industry accepted standards and commercially available products to the maximum extent possible to support the system requirements;

- use well-defined application program interfaces between the models and the support services,

- be portable and have the ability to execute across heterogeneous platforms. It shall be capable of being transferred between homogenous and heterogeneous platforms with minimal or no modifications;

- optimize the interdependencies between software components so that the impact of change is localized; and

- possess a software architecture that is consistent with the architectural framework described in the DoD Technical Architecture for Information Management (TAFIM), and is depicted notionally as four layers of software.

3.5.1 Object Oriented Development

NASM shall be developed using object oriented analysis, design, and implementation. NASM shall provide a common system object repository facility including configuration control, to allow USAF wargaming without joint or multiple service participation. The common framework shall support both physically local and wide area repository support. To the users of the object repository it shall appear that is a single logical repository.

3.5.2 Software Development Environment

A software development support environment that includes automated tools and or manual processes that enhance productivity and allow for the ease of developing/changing the application software, shall be employed. A distributed software development environment shall be considered.

3.5.3 Common Services

NASM shall provide common services comprised of tools and reusable shared software components for use by service objects and models. Services will be products that range from low-level system utilities to higher-level application, such as database management.

Common services will be comprised of components which meet Government and industry standards promoting open architecture in a multiple vendor heterogeneous environment. These services shall include such components as: network services, graphics, security, operating systems, documentation, instrumentation, system management, distributed computing environment, knowledge servers, and other services.

NASM shall provide utilities and tools to support error handling, system monitoring and system debugging. The tools provided shall allow the messages within NASM to be displayed in an human-readable format.

3.5.4 Human Factors Engineering

3.5.4.1 Technical Controller Displays

The design of the displays shall be based upon guidelines compatible with industry standards. The NASM user displays designs shall provide ease of use and convenience to the technical controllers. On-line help shall be available.

3.5.4.2 End User Displays

NASM shall provide severable component user interface definitions, representing real world C2 (e.g., CTAPS), simulator and simulated entity level platform/systems, operator consoles, and others as appropriate to the simulation user. Severable user interface definitions imply user interface displays are not hard-coded and possess a "natural" breakout of user functionality.

3.6 System Behavior and Design Characteristics

3.6.1 Adaptability

The NASM system shall be developed to be adaptable. Adaptability will be essential for the NASM architecture, since it must support not only the current Air Force simulation requirements based on the Air Warfare Simulation (AWSIM) but newly identified additional operational requirements, educational requirements, and future simulation capabilities not yet identified. The NASM architecture shall also be adaptable to support for rapid introduction/insertions of advanced technology within the system. The architecture also needs to allow NASM to evolve for broader applications, such as information warfare, and to be tailored to site-specific needs (ranging from seminar training though major exercises). To achieve adaptability, the NASM architecture shall be flexible, extensible, evolvable, and scaleable.

3.6.2 Flexibility, Extensibility, and Evolvability, and Scaleability

The NASM design shall accommodate growth. The NASM system shall be designed to accommodate simulations identified by future user communities (e.g., analysis, test and evaluation).

The NASM design shall have the ability to readily accommodate modifications and additions to satisfy the evolving requirements in both the NASM architecture and the NASM simulations.

The NASM system architecture and design shall have the flexibility and extensibility to accommodate changes to the architecture which include changes to the architectural components.

The NASM system design shall be scaleable to accommodate the ability to model thousands of entities at varying levels of fidelity.

Methods to ease portability of the models to a new environment containing hardware and software services that may differ from the original implementation shall be employed.

3.6.3 Repeatability

The NASM simulation executions shall be repeatable; that is, if the same simulation runs twice with the same inputs supplied at exactly the same times, including seeds for random elements, the simulation results will be identical..

3.6.4 Causality

NASM shall support maintenance of causality of events. The maintenance of the causality of events is the preservation of the time step order when distributing events between simulations, (i.e., events received by two or more simulations will receive the events in the same relative ordering) and no event/data will be delivered in the past.

3.6.5 Distributed Computing

The "train where you fight" requirement has lead NASM to be scoped as a distributed simulation system across potentially long haul disparate geographical areas. Distributed computing shall apply to all aspects of the NASM system, not just to the execution phase of an exercise. Data access as well as processing shall be capable of being distributed. Pre-exercise planning and setup shall support the capability for the training staff to be located at different physical locations and on different equipment, yet capable of coordinating their activities (having shared access to the same information in a controlled manner) and collaboratively planning an exercise. During post-exercise activities, different individuals shall have the ability to access the raw exercise results for analysis and after action review, and that access shall be supported from widely separated locations. The NASM development environment shall also support distributed system development and integration.

3.6.6 Interoperability

NASM shall interoperate with those systems defined in sections 3.4.2, 3.4.3, and 3.4.4. NASM system architecture shall be designed to easily accommodate requirements for interoperability with future systems.

3.6.7 Reliability and Availability

NASM shall be capable of operating 24 hours per day, 7 days a week. NASM shall be capable of support training exercises whose duration ranges from 1 to 30 days, 24 hours per day.

NASM shall be capable or restarting an exercise from the point of failure no more than one hour after a correction from a system failure.

3.6.8 Maintainability and Supportability

The NASM system shall be maintainable and supportable. Sufficient data shall be developed and delivered to support a two level maintenance concept: organizational and depot. Each level shall support both on-equipment and off-equipment maintenance.

NASM shall be designed and developed to support the transition from the current air force training model(s).

3.6.9 Training

NASM shall be designed to minimize NASM system training requirements and the life cycle costs of training. Training shall be provided for all NASM users described in section 3.1.

No more than 12 hours shall be required to train new technical controllers and no more than 6 hours shall be required to train end user (i.e., players).

Maximum training time for each of the NASM specific external interfaces (i.e., Real world, external systems (e.g., JSIMS, WARSIM) shall be no more than 2 hours for familiarity and no more than 6 hours for proficiency.

3.6.10 Performance

NASM shall be capable of supporting an exercise with variable number of sides including: 5 services from 10 nations (5 services per nation) in coalition, neutral forces, suspect, and opposing forces.

TBD -- Maximum size of scenario, including maximum number of mission per exercise, maximum number of individual assets (including radars, maximum number of end users, exercise duration. Include requirements for balanced scenarios.

3.6.11 Security and Trust

NASM shall provide for a minimum of two concurrent levels of classifications, ranging from unclassified to top-secret (including special compartmented categories). Security labeling and control of data shall be based upon the security classification levels (Unclassified, Confidential, Secret, and Top Secret, etc. as well as caveats (NOFORN, NATO Releasable, Releasable to UK/CAN. WNINTEL, etc.) Support systems shall require protection from unauthorized access. Systems shall require protection from computer viruses. To the extent practical, NASM software shall be unclassified. Software modules that contain classified data and algorithms shall be written and integrated with the remainder of the NASM software in a manner that permits the remainder of the software to used, stored, and generally treated as unclassified. NASM shall be readily integrated into a site's physical facility without requiring any additional physical security enhancements over those presently required for AWSIM. NASM resident data shall be classified no higher than secret . Top secret and compartmented information shall be sanitized to secret prior to use within NASM.

3.6.12 Software Languages

NASM shall be developed using Ada to the maximum extent possible.

Considerations that may affect software language choices are backward reuse, commercial or government standards, and the use of a particular development methodology, e.g., object oriented. All software languages used to develop NASM shall be supportable across heterogeneous platforms. Proprietary software languages shall not be used.

4. Not Applicable

5. Not Applicable

6. Notes

6.1 Aggregation/Deaggregation

To support the capabilities required for aggregation and deaggregation the NASM architecture must provide several key capabilities.

- Architecture must support the dynamic creation and removal of entities during the exercise when entities are deaggregated and aggregated. This includes aspects of entity identification, initialization from aggregate data upon deaggregation, data collection among others. Architecture must also support the reaggregation of entities in the exercise. Reaggregation would aggregate component entities together that were once an aggregate entity.

deaggregatedeaggregationdeaggregationdeaggregationdeaggregation

- Architecture must be able to deaggregate entities into sub-entities on a distributed network. De-aggregating an Air Command into it sub-entities may result in the formation of numerous entities. These entities may need to be distributed across nodes in the computer network to satisfy run-time requirements for the exercise. This is also true for aggregating entities together. These entities that will form the aggregation may be located on different nodes.

- Architecture must provide a consistent mechanism that will handle the deaggregation and aggregation of entities within the exercise. Aggregate objects must supply information to the architecture related to the aggregate entity, such as overall size, number on entities within the aggregate, information on entity layout upon being deaggregated to allow for correct laydown of disaggregated entities.

- The architecture must have the capability to represent entities both at the aggregated level and at the deaggregated level (i.e., NASM entities may be grouped/ungrouped into/out of more aggregated entities and NASM entities may internally have multiple levels of resolution). One entity may be close enough to an aggregated entity that this entity must be deaggregated so that its sub-entities are visible to this other entity.

However, there may be another entity in the exercise that should not be able to view the sub-entities of this aggregated entity and thus the aggregated entity should remain aggregated with respect to this second entity.

6.2 External Interfaces

The dimensions of the problems of interfacing to real world systems and to external, non-HLA simulations are very similar. A typical solution to both problems is to define an interface object which will convert data between the format used by the external simulation or live system and the internal data format used by NASM. (The DMSO-sponsored Modular Reconfigurable C4I Interface (MRCI) is an example of a generic interface object). This will include scaling, byte swapping, floating point conversion, and coordinate system transformation, as needed. Both synchronous and asynchronous data must be handled. One way to accomplish this would be through the use of data interchange & transformation agents. To facilitate development of data interchange & transformation mechanisms and their configuration into simulations, the NASM architecture must provide the following features:

- A standard Object Model Template for data interchange & transformation of objects and their attributes;
- "Mix and match" communications services which can be configured to handle the required interfaces to external simulations, ranging from satellite link to TCP/IP to serial data link;
- A standard API for communications services, so that new communications protocols may be added to NASM easily
- Isolation of a physical system translation layer for each external system instance to afford maximum reuse between the API and the system specific layer.
- A language for specification of formats, timing, and conversion requirements of data interchange, and associated tools for rapid input and maintenance of interface specifications.

6.3 Repeatability

When interfacing many systems into a working whole, it is necessary to decide whether the simulation must be repeatable. Repeatability means that the if the same simulation is run twice with the same inputs supplied at exactly the same times, including seeds for random elements, it will produce exactly the same outputs. In general, low level simulations such as tactical simulations and engineering analysis are more likely to require repeatability than higher order simulations. If the simulation includes human input, it may be impossible to reproduce the inputs exactly, but repeatability may still be required for the computer-generated portions of the simulation.

Repeatability is affected by the synchronization methods used by the simulations. A simulation can only guarantee repeatability when a coordinated time synchronization method is chosen, meaning that all nodes must indicate their readiness to advance the simulation time before time is advanced for all. Scaled real time synchronization does not require agreement, so repeatability becomes the responsibility of the modeller, requiring careful analysis of the average and worst-case response times for all elements of the simulation.

6.4 Architectural Considerations

The architecture that exhibits these characteristics needs the following features:

a) The architecture itself must be comprised of modular, object-based components. Such a design inherently fosters data encapsulation and well-defined interfaces.

b) Architectural objects must interact with each other and with modeling objects during execution of an exercise through a potentially distributed, location-transparent, well-defined Application Program Interface (API). This feature is critical to support the interchange of live, virtual, or constructive simulations for the same entity.

c) The architecture must treat all model objects as "black boxes", interacting only through the architecture API. There can be no specialized "god's-eye" understanding coded into the architecture of the nature of the models, as has been done with traditional simulation executives.

d) The services provided by the architecture should be organized into layers or levels, ranging from "kernel" to higher-level services such as interaction resolution managers. "Kernel" services should be restricted to primitive operations such as object-object distributed communication, event scheduling and timing, data access, and message logging, which are basic to a simulation. Higher level services are more likely to require tailoring for a specific simulation. Well-defined interfaces will be required between each layer to allow for replacement.

e) A well-defined, generic API will be needed for tools, executing as standalone programs, to execute within the architecture framework. This API should be conceptually like that specified in the OMG's CORBA specification.

An architecture with these characteristics will exhibit both flexibility and extensibility because it will be easier to replace any given architecture component, to incorporate new tools, to reconfigure the distribution network, and to support a variety of different models and simulation applications. Adjusting the scale of execution will be a matter of configuring a network with adequate resources and possibly selecting specific versions of standard services appropriate to the level. This results from the fact the architecture is inherently distributed, that services can be added and replaced, and that there is no model-specific knowledge embedded in the architecture. Interchanging live, virtual, or constructive simulations for the same entity is made possible by the use of an interface object that maintains the same standard interface to the rest of the simulation regardless of what provides the entity's functionality.

6.5 Distributed Computing

During the execution of the exercise distributed computing will be important for a number of reasons. First, the very nature of the exercise itself often requires the participants to be at their separate locations where they would normally carry out their roles and using their normal equipment. This includes not only the trainees, but the game controllers or instructors as well. Second, for the exercise to include live or virtual components whose physical locations are fixed, there must be communication across a distribution network. Third, those simulated components of an exercise which are legacy systems are likely to be platform-specific and hosted at a particular physical site. Finally, there may be a need for distributed processing in order to achieve the required throughput from the various simulated components, either because of their sheer numbers or because of the level of detail of the simulation. A NASM simulation, in addition to being distributed within itself, must also interact with other simulations across a distributed network as part of a High Level Architecture (HLA) federation.

The architecture that supports these capabilities would need the following features:

a) <u>A mechanism for distributed concurrent shared data access.</u>. All data access by simulation or architecture entities would have to be through this distributed data mechanism to guarantee transparency of data physical location and maximum flexibility in system configuration.

b) <u>Transparent built-in distribution of all interactions between entities in the system</u>. whether simulation or architectural. There must be no assumptions embedded in either the modeled objects or the architecture about physical locations or whether entities are on the same system or not. Ideally, all interactions should follow a paradigm similar to that described in the Object Management Group's (OMG's) Common Object Request Broker Architecture (CORBA). Following this model, entities will use the same interface to interact whether their location is local or remote, and the NASM architecture will handle determining the location, passing distributed messages, and any synchronization issues. Ideally, the NASM architecture will make use of a commercially available infrastructure software system to provide this capability.

c) <u>No (or at least tightly isolated) system dependencies.</u> System dependency has been a traditional drawback to distributed processing. However, the NASM architecture must not only operate over a variety of hardware platforms, but must be readily adaptable to new hardware which does not yet even exist. The physical network configuration will likely differ from one NASM session to another, and may even change during the execution of a NASM exercise. Whether the nodes are connected by a Local Area Network (LAN) or Wide Area Network (WAN) should be transparent to the architecture. Likewise whether a "best effort" or "guaranteed receipt" protocol is used must be readily altered to suit the particular circumstances. Commercial ORBs may also address this capability.

d) <u>Flexible, user-friendly configurability to the available hardware</u>. A "user" - meaning in this case, an exercise controller or system support person - should be able to specify what will be distributed and how through a user-friendly, interactive Graphical User Interface (GUI). Network configuration should not require changes to the architecture software or use of obscure system files. Some commercial ORBs may provide a preliminary version of this capability.

e) <u>A means to predict and monitor the performance of a particular exercise configuration</u>. This should include a modeling tool that allows a system support person to specify not only the hardware configuration but also the software distribution and to generate projected performance statistics for a given configuration. The software distribution refers to the location and grouping of software objects. Performance predictions would be based on some description of the predicted interactions between objects and statistical information about the performance of each object. Commercial tools to predict performance of the hardware components of a system are available now. Analysis of the software components will have to be developed.

Some of the distributed computing issues to be addressed by NASM include portability and the heterogeneous nature of the distributed components, issues impacting network performance, and compliance with an HLA compliant Runtime Infrastructure (RTI).

GLOSSARY

Aggregate - To combine multiple entity representations into a single entity representation, with the aggregate providing the correct behavior representation. A classic example is that of two individual friendly aircraft which, even in close proximity, behave significantly different than a coordinated flight of two aircraft. Aggregation can also apply to effects (e.g., Electronic Warfare) and types of representations other than force representations. Aggregation: The ability to group entities while preserving the effects of entity behavior and interaction while grouped.

Constructive Model or Simulation - A form of simulation, which for the training domain are commonly called wargames, that involves software representation of two or more opposing forces, using rules, data, and procedures designed to depict an actual or real like situation.

Deaggregate: To create multiple entities from an aggregated entity, the entities contained within the aggregated entity to be seen as individual entities.

Hot Wash - a review meeting which is held concurrent with or immediately following a session of training (an exercise) to summarize initial impressions and lessons learned.

Joint Synthetic Battlespace - an operationally realistic, distributed, simulated mission space that includes a synthetic environment, force representations, and behavioral representations.

Live Simulation - A simulation involving real people operating real systems. In the case of NASM this includes the use of real world C4I by simulation participants.

Mission Space - Mission space refers to the entities, actions, and interaction that must be represented to produce credible simulations of the specific mission area being addressed. Mission space includes all elements which support the simulation and which are required to achieve the desired goals and objectives. The mission space is comprised of force, behavior, and environmental representations.

Model - (1) A representation (executable or not) of real things or events, (e.g. terrain, air, space land, sea) (2). A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process.

Models - a group or combination of the models (e.g., synthetic environment)

Scenario - (1) Description of an exercise (initial condition in military terms). It is part of the session database which configures the units and platforms and places them in specific locations with specific missions. (2) An initial set of conditions and time lines for significant events imposed on trainees or systems to achieve exercise objectives.

Simulation - (1) A model that behaves or operates like a given system when provided a set of controlled inputs. (2) The process of developing or using a model as in (1). (3) An element of a special kind of model that represents at least some key internal elements of a system and describes how those elements interact over time.

Simulation Entity: An element of the mission space that is created and controlled by a simulation. Each entity may be implemented in software by one or more objects or modules. Represented entities range in size from subcomponents to aggregated units. Entities can be comprised of other entities. It is possible that a simulation application may be controlling more than one simulation entity. An entity in terms of NASM is any thing or any group of things which may be modeled discretely (e.g., could range from a tank through a Corps).

Simulation Exercise - Consists of one or more interacting simulation applications. Simulations participating utilize correlated representation of the synthetic environment in which they operate. NASM will be composed of simulations components instanced for a particular exercise.

Simulation System - a group of simulations packaged with ancillary functions (i.e., terrain database, thereat database, engagement database) that may interface to external systems (e.g., NASM).

Simulator- (1) A special case of virtual simulation that provides an encapsulated virtual environment for interfacing with the simulation system. (2) A device, computer program, or system that performs simulations. (3) For training a device which duplicates the essential features of a task simulation and provides for direct practice. (4) A physical model or simulation or a weapon system, set of weapon systems, or a piece of equipment which represent some major aspects of the equipment's operation.

Virtual simulation - A simulation involving real people operating simulated systems. Virtual simulations inject WITL in a central role by exercising motor control skills, decision skills, or communication skills. Form of a simulation in which entities exist in effect or in essence, although not in actual form. Virtual simulations typically represent a single platform entity.

IOC/FOC FUNCTIONAL DESCRIPTION

The NASM IOC system shall:

- o shall support at a minimum representations included in the re-engineered version of AWSIM; (Details regarding functionality related to re-engineered AWSIM can be found in the AWSIM/R System Specification.)
- o provide a complete distributed, discrete event, constructive simulation system that supports Air Force and joint battlestaff training for all aerospace missions;
- o provides all air and space models necessary to support the USAF component of JSIMS;
- o provide a complete standalone training capability to train the battlestaff; including pre-exercise, exercise, and post-exercise capabilities.
- o interface to the other simulation systems in order to satisfy the joint training requirements;
- o develop and implement missions (e.g., aerospace mission, MOOTW) necessary to satisfy the joint training requirements.
- o interface to the following real world interfaces: TBMCS, C2IPS, TADILs, and TIBS.

With respect to the capabilities described in section 3.2.2.2 Aggregation and Deaggregation and 3.2.2.3 Behavioral Representation (semi-automated forces and computer generated forces), partial capability sufficient enough to support battlestaff training shall be provided within the NASM IOC system reducing at a minimum by one third the resources required to perform an exercise (both technical controllers & role-players).

The NASM IOC and subsequent releases shall be delivered and installed at the following four sites: WPC, BTS, JWFC, and Air University.

The releases post IOC shall evolve the NASM system to satisfy all remaining additional external simulation systems and real world interfaces. The Post IOC releases shall also address additional eductional requirements. The FOC system shall also satisfy the additional mission requirements for MOOTW, information warfare and special operations not included in previous releases. All of the requirements described in this TRD shall be satisfied by FOC.

ACRONYM LIST

AAM	Air to Air Missile
AAR	After Action Review
ACO	Air Coordination Order; Airspace Control Order
ADANS	AMC Deployment Analysis System
ADS	Advanced Distributed Simulation
AFM	Air Force Manual
AFMC	Air Force Materiel Command
AFMSS	Air Force Mission Support System
AFWI	Air Force Wargaming Institute
AFR	Air Force Regulation
AMC	Air Mobility Command
AMG	Architecture Management Group
AMRAAM	Advanced Medium Range Air to Air Missile
AOC	Air Operations Center
ASM	Air to Surface Missile
ATO	Air Tasking Order
ATOCONF	Air Tasking Order/Confirmation
AWSIM	Air Warfare Simulation
BDA	Battle Damage Assessment
BTS	Battlestaff Training School
BVR	Beyond Visual Range
C^2	Command and Control
C2IPS	Command and Control Information Processing System
C^3I	Command, Control, Communications, and Intelligence
C^4I	Command, Control, Communications, Computers, and Intelligence
CAS	Close Air Support
CGF	Computer Generated Forces
CIS	Combat Intelligence System
CMARP	Combined Mating and Rating Planning System
CMMS	Conceptual Model of the Mission Space
COMPUSEC	Communications Security and Computer Security
COMSEC	Communications Security
COTS	Commercial off-the-shelf
CTAPS	Contingency Theater Automated Planning System
DCA	Defensive Counter Air
DIA	Defense Intelligence Agency
DIS	Distributed Interactive Simulation
DMPI	Desired Mean Point of Impact
DMS	Digital Mapping System
DMSO	Defense Modelling and Simulation Office
DoD	Department of Defense
ESC	Electronic Systems Center

ESR	Equipment Status Reporting
FID	Foreign Internal Defense
FOC	Full Operational Capability
FOM	Federation Object Model
GCCS	Global Command and Control System
GDSS	Global Decision Support System
GOTS	Government off-the-shelf
HIMAD	High and Medium Range Air Defense
HLA	High Level Architecture
HQ	Headquarters
ICD	Interface Control Document
INFOSEC	Information Security
IOC	Integrated Operational Capability
JCMT	Joint Collection Management Tool
JDISS	Joint Deployable Intelligence Support System
JECEWSI	Joint Electronic Combat Warfare Simulation
JFACC	Joint Forces Air Component Commander
JSIMS	Joint Simulation System
MAP	Master Attack Plan
MDC	Maintenance Data Collection
MISREP	Mission Report
MOOTW	Military Operations Other Than War
MRC	Major Regional Contingency
MSFD	Multi-Spectral Force Deployment
NASM	National Air and Space (Warfare) Model
NATO	North Atlantic Treaty Organization
NATSIM	National Intelligence Simulation
NDI	Non-developmental item
OOB	Order Of Battle
OCA	Offensive Counter Air
OMA	Object Management Architecture
OMG	Object Management Group
OPFOR	Opposing Forces
PGM	Precision Guided Munitions
PSYOP	Psychological Operations
R&M	Reliability and maintainability
RTI	Run Time Infrastructure
SAFOR	Semi Automated Forces
SAM	Surface-to-Air Missile
SEAD	Suppression of Enemy Air Defenses
SEI	Software Engineering Institute

SHORAD	Short Range Air Defense
SOF	Special Operations Forces
SOM	Simulation Object Model
SPT	Self Protection Jammer
SSF	Software Support Facility
STD	Standard
STOMPS	Standalone Tactical Operational Message Processing System (STOMPS)
TADIL	Tactical Data Information Link
TBD	To be determined
TBMCS	Theater Battle Management Core Systems
TELS	Transportable Erector Launcher System
TEP	Tactical Elint Processor
TIB	Tactical Information Broadcast System
TPFDD	Time-Phased Force and Deployment Data
TRAP	TRE and Related Applications
TRD	Technical Requirements Document
TRE	Tactical Receive Equipment
USAF	United States Air Force
USMTF	U.S. Message Text Format
WAN	Wide Area Network
WARSIM	Warfighter's Simulation
WCCS	Wing Command and Control System
WITL	Warfighter-in-the-loop
WOC	Wing Operations Center
WPC	Warrior Preparation Center
WVR	Within Visual Range